THE HILL KINK BOOKS

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# REPAIR KINKS

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COMPILED BY

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# INTRODUCTORY WORD

THE kinks and other information given in this book have been selected from the experience of thoroughly practical men, as originally published in the *American Machinist*. This volume forms one of a series of this nature, aiming always to make available out-of-the-way information when most wanted. In this form the Kink Books, which can be kept in the tool-chest or the pocket, and always referred to, will, we feel, meet a demand and serve a good purpose.

F. H. COLVIN.
F. A. STANLEY.

NEW YORK, November, 1907.

# REPAIR KINKS

## GETTING A BROKEN TAPER SHANK OUT

THERE are times when a stem or shank fitting tight in a hole is broken off short or flush with the face; if the shank bottoms and no means have been or could be provided to drive it out from the bottom, it is an awkward job where the parts are heavy or awkward to handle to get it out. In such a case, drill a hole proportionate in size to the stem to be removed (for a 4-inch stem say a 1-inch hole) right through the shank to the bottom of the hole or end of the shank, then turn a steel punch an easy fit for and a little longer than the hole.

Now put a pinch or two of blacksmith's coal in the hole and, putting the punch in on top of the coal, strike the punch a smart blow with a sledge hammer and the gas generated by percussion will either lift it out at once, or by forcing

its way into the interstices loosen it so that another blow or two will do the trick. It is obvious that the hole must be drilled to the end of the shank and bottom of the hole for the gas to be effective.

## GETTING OUT A BROKEN TAP

A FRIEND of mine had a tap break the other day, a piece of it being left in the work. When I arrived upon the scene, he was trying to get it out with the aid of hammer and chisel. His usual procedure in such cases (which I believe is the method generally adopted) was to heat up the work, if not too large, till the broken tap was soft enough to allow a hole to be drilled in it and then knock in a square punch, by which means the broken piece can sometimes be removed. In the present case it was impossible to use this method, as there were aluminum parts attached which would be spoiled if made hot. With the aid of a blowpipe broken taps can sometimes be softened without damaging any of the surrounding parts, as the flame can be directed

upon the tap alone. Seeing the trouble in this case reminded me of the little tool shown in the accompanying sketch which I first made the acquaintance of many years ago. During my apprenticeship I had broken a tap in a valuable piece of work which was very urgently wanted. I tried all the ways I could think of to get it out, but all to no purpose. I was afraid to show the foreman what I had done, so I asked the

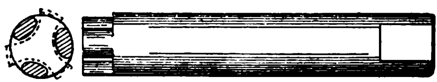


Fig. 1. — Wrench for Getting out Broken Taps.

advice of an old hand who had previously put me up to many little kinks. He quickly made a tool like the one shown, and soon had the broken piece out. As will be seen in Fig. 1, the three projecting parts go into the corresponding grooves of the tap. The diameter of the tool should, of course, be a little less than that of the bottom of the thread.

While none of these devices are always appli-

cable, as it is probably the exception rather than the rule for taps to break off square, they are still handy to know about.

## GETTING OUT BROKEN STUDS

MANY advise against the use of a square drift for removing broken-off studs, because, after drilling out the inner stock and thereby relieving the tension, driving in that square drift will press the threads together tighter than they were at first, making the success of the operation doubtful. A left-handed flat drill is sometimes recommended.

I believe this experience with a square drift is a very common one and therefore I give my way of tackling a broken-off stud, say $\frac{3}{4}$ inch. First I hunt for or make a straight piece of square tool steel of such a size that it will measure over the corners a little less than the tap drill for that size. As $\frac{7}{16}$ inch square measures scant $\frac{5}{8}$ inch over the corners, it will do. Drill the hole $\frac{1}{64}$ inch smaller than this size. Grind one end square and then temper that straight

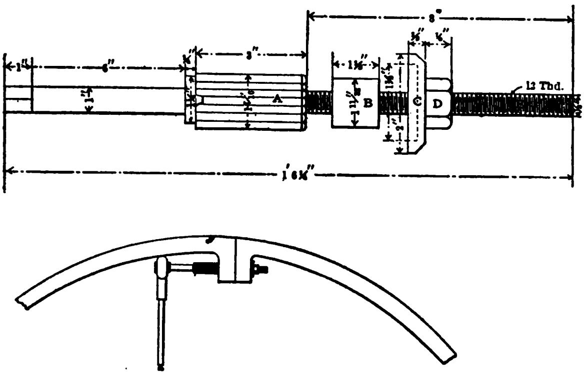
piece of tool steel and draw to a blue all over. It is then at its best to stand torsion and hard enough to cut the four little grooves, each one-half of $\frac{1}{64}$ inch deep, away through the hole in the stud without expanding it. Now apply a tap wrench or whatever tool is handy.

It may seem that the hole was drilled too big and that the drift would turn without taking the stud along. In order to do this, that drift would have to act as a square reamer, enlarging the hole at the rate of $\frac{1}{64}$ inch per quarter of a turn or $\frac{1}{16}$ inch per each turn. Anybody who ever reamed holes with a square reamer such as taper pin holes, knows how little it takes to make that reamer stick to the breaking point, and how many more than one turn it takes to enlarge a hole to the amount of $\frac{1}{16}$ inch.

## A MAKESHIFT REAMING DEVICE

THE illustrations show a "makeshift" that has proven of great benefit. The device is used for reaming holes in cramped places where ordinary methods and appliances are not available,

such as for the rim bolts in large sectional fly-wheels, sheaves, etc., and even for use in places where it outclasses the ordinary ratchet drill and old man even where the latter can be used. For instance, in using the device on a sectional wheel,




FIGS. 2 and 3. — Makeshift Reaming.

the holes are carefully laid off and drilled $\frac{1}{16}$ inch under size, when the sections are put together, clamped into position and the holes reamed as shown in Fig. 3.

With a device of the dimensions shown $\frac{1}{16}$ inch can easily be reamed out of a $1\frac{7}{16}$ inch hole,

with a 16-inch ratchet stock. It can readily be elaborated upon to meet the requirements of the job in hand. In Fig. 2 *A* is an ordinary shell reamer such as found in the standard sizes as part of the equipment of nearly every shop in the land. *B* is a sleeve made $\frac{1}{32}$ inch smaller than the drilled hole and is used to keep the stock and reamer straight with the hole in starting. This is, of course, to be taken out as the finished hole nears completion. *C* is a recessed washer made to allow the point of the reamer to project beyond the end of the work, and against which the feed nut *D* bears as it pulls the reamer through. *E* is the stock used for this work and, in connection with an ordinary ratchet drill stock to fit on the squared end and drive it, forms the whole equipment.

## BUSHINGS FOR HIGH-SPEED LOOSE PULLEYS

To those who have had trouble with high-speed loose pulleys wearing out in the bore, I would recommend the scheme shown in Fig. 4. A

brass, or, preferably, a phosphor bronze bushing, turned a driving fit in the pulley hub, is first drilled with $\frac{3}{16}$- or $\frac{1}{4}$-inch holes staggered as shown, and the holes are then forced full of Dixon's No. 690 graphite compound. A small oil hole should also be provided, as it is best to occasionally use a small quantity of oil which

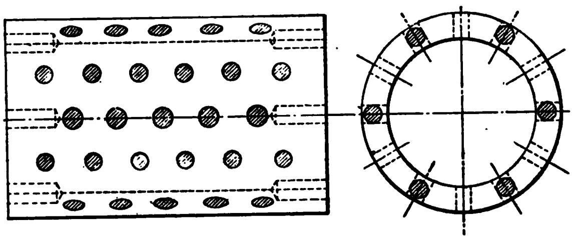


FIG. 4. — Bushing for High-speed Loose Pulley.

with the compound makes a paste which lubricates nicely, even though the shaft be slightly cut or uneven. Should the pulley heat, the mixture softens and lubricates without attention.

Bushings made as described, and used on an emery-wheel countershaft, have run for more than a year with little wear, whereas those made

of cast iron, brass and phosphor bronze without the compound had quickly failed.

The compound comes in sticks wrapped in foil. It is inexpensive, and the trouble avoided will certainly pay for the cost of the job.

## LOOSE-PULLEY OIL HOLES

When a pulley sticks and keeps sticking, drill a quarter-inch hole through the hub parallel with the oil groove and plug up the ends. If there are not oil holes on both sides of the hub, drill one directly through the parallel hole just drilled to the shaft and stop up the outside of one hole. The object is to convey oil to both sides of the hub, which when the oil groove is clogged will flow through the parallel hole.

A loose pulley which will not stick and gives excellent satisfaction with high or low speeds is made in the following manner, as shown in Fig. 5. A composition bushing with three ribs, the center one cut through as shown in the illustration, is turned a driving fit for the pulley. Between the ribs a line of holes is drilled as close together as

possible; these are filled with leather or felt punchings made with the common belt punch. When this bushing is driven in place it gives an

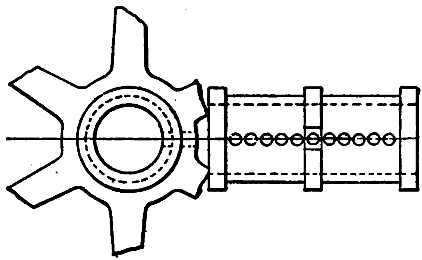


FIG. 5. — Bushing for a Loose Pulley.

oil chamber large enough to hold oil for months. Sufficient oil is transmitted through the felt or leather plugs to lubricate the pulley. The leather plugs do not glaze and convey sufficient oil.

## RE-BORING A PULLEY

THE manager of a brick yard came into our shop and asked if we could bore out a big pulley for him. It was one they used to have on a 3-inch shaft, but they had not been using it for some time and now wanted to put it into service

...n on a $3\frac{1}{4}$-inch shaft. It was a solid cast pulley, about 60 inches in diameter and 12- or 14-inch face. The hub was about 10 inches long,

He wanted to get that big pulley bored out to go on a larger shaft than it was intended for when made. There was neither lathe nor boring mill in our small town that would swing 60 inches. But he wanted to avoid sending that pulley fifty miles by rail, paying freight both ways, so he asked if we could bore it, and then was not inclined to think us in earnest when we told him we could.

"Bring it right up," said I, "and by this time to-morrow it shall be ready for you." He said he would have the pulley sent right up, so I started at once to get ready for the job.

We had odds and ends of shafting in the shop, so, taking a piece of $3\frac{1}{4}$-inch shafting, about $2\frac{1}{2}$ or 3 feet long, I turned one end for about 6 or 8 inches, allowing for a finishing cut when the pulley should arrive so as to form a pilot nicely fitting the old bore. At the shoulder formed by turning I drilled a hole and inserted a boring tool the end of which was just flush with the

large diameter, and the cutting edge of which was about $\frac{1}{32}$ inch in advance of the shoulder, thus regulating the amount of feed.

I splined from the end of the shaft up to the tool to allow the chips to drop down, then when the end was turned to fit nicely in the bore of the pulley, which by that time had arrived, we were ready for business. And I might add right here, for the consolation of some of my fellow job shop operators, that the work yet to be done on that pulley was about the only part of the job that many of our customers could have distinguished as belonging to them. That was all right in this case, as they neither saw the tool made nor the pulley bored, and I do not now remember whether they knew how the job was done or not.

With the pulley laid flat and blocked up about a foot from the floor, the bar inserted and a dog put on the upper end, between the tail of which and the shaft a piece of 1½-inch gas pipe, long enough to extend well across the pulley was laid, two men walking round and round the pulley easily and accurately bored out the hole, or

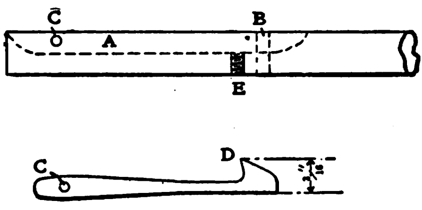
counterbored it, if that would be more correct. The bar being pretty heavy furnished all the weight or pressure needed to feed it into the work. While others may suggest other ways, still I think this method of re-boring a pulley is about as simple and cheap as any, especially as you can employ the very cheapest of labor to do the boring.

## A KEYSEATING TOOL

THE illustration shows a tool made to keyseat some gun-metal articles and, as the hole was $\frac{3}{8}$ inch diameter by 2 inches long, I thought it impracticable to chip or file them — the more so, as they had to slide on the shaft without much shake. This necessitated a smooth, straight keyway.

I took a piece of $\frac{3}{8}$-inch shaft about 12 inches long, milled a keyway *A* in it about 3 inches long, as in Fig. 6, and inserted a tool shaped like Fig. 7. *B* is a $\frac{1}{8}$-inch pin for a stop to take up thrust, *C* is a $\frac{1}{16}$ pin holding tool in slot, *D* is the cutting edge.

I then held the articles in the universal chuck of the lathe, the tool mounted in the tool-post of the lathe. I then pushed through, tightening




FIGS. 6 and 7. — A Keyseating Tool.

$\frac{1}{8}$-inch screw *E* each cut. The tool and twelve keyways complete took $1\frac{1}{2}$ hours.

## A KEYWAY BROACH

ON repair work and various other jobs the keyway broach shown in this sketch is sometimes a very handy tool — that is, where any degree of accuracy is required. As, for example, we recently had a repair job where three separate arms were held closely together on a shaft, their location being very important.

These arms were a driving fit on the shaft and

on the feather which held them in position. In the repairing a new shaft was required in which the keyway was milled slightly larger than the keyway in the arms.

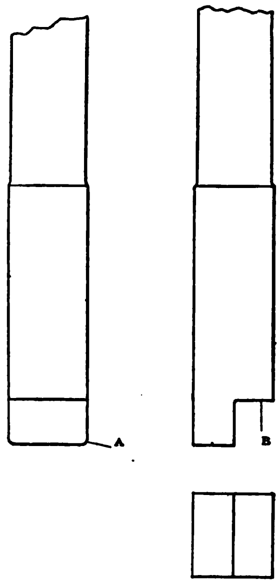



FIG. 8. — Keyway Broach.

The arms were driven on and placed in exact position on the shaft. The broach was lightly

driven through, making the keyway true and the same size as the keyway in the shaft.

The pilot of the broach at *A*, Fig. 8, is rounded off to prevent it from cutting the keyway in the shaft. The broach after being tempered should be ground on a surface grinder and very slightly cleared on the two sides of its cutting edges at *B*.

## REPAIRING A WORN CLUTCH

THE sketch shows a clutch on a main line shaft $5\frac{3}{8}$ inches diameter, which ran in a pit. The clutch gave us considerable trouble in throwing it in to drive a machine. The groove in the clutch was for the usual clutch dog, which with an arm and lever shifted the clutch to engage in its mate on a large pinion which drove the machine. This clutch dog by constant use (and inconstant lubrication) had worn away the face of the groove, as shown by the curved line *a*, Fig. 9. To cure the trouble it was at first thought necessary to replace the clutch by a new one, which would have meant the moving of two large machines, taking off one large pinion, re-

moving shaft and coupling, putting on a new clutch and then replacing all. The shaft was run night and day with only fifteen minutes' stop in twenty-four hours, so repair must be made on a Sunday. The method adopted was much sim-

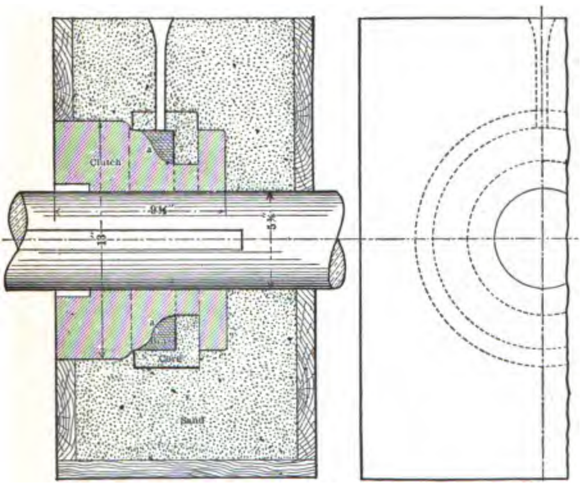



Fig. 9. — Repairing a Worn Clutch.

pler and the cost nothing as compared with a new clutch.

Had a box or flask made in two sections to fit the shaft and enclose the clutch. Then braced

the lower half up against the shaft and the jaw end of the clutch. The core shown was made in two sections so that it could be placed around the clutch. One-half of the core was placed below and held there while sand was packed around it to hold it firmly. Next the upper part of the flask was placed on and clamped. The upper core was then placed with a hole at the top for pouring the metal. Sand was rammed in, with the gate left for pouring, and then brass was melted and poured without a hitch. The brass flowed against the core and made the clutch as it originally was. When the brass cooled it shrunk to a tight fit. Small projections were chipped off and filed and the job was done. It was successful in every way, requiring only two men to do it complete in about seven hours.

## REPAIRING WORN CHUCKS

THE ordinary style of jaw chuck almost always develops an excessive amount of wear at the shoulders *A*, Fig. 10, as the thrust of the screw

is on a half circle bearing and the chuck body is generally soft iron. Chucks worn in this way can be repaired by making a gang milling cutter the shape of the half bushing shown at *D*, then milling the chuck as shown by the dotted lines at *B*. The bushings are made of tool steel

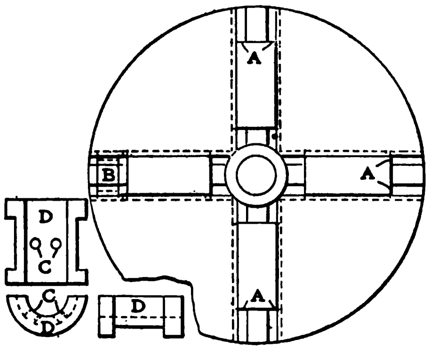



Fig. 10. — Repairing Worn Chucks.

hardened. They can be easily made by chucking two pieces together, thus finishing two halves at once. Before hardening they should be fitted in place, and the holes at *C* drilled for dowel pins to keep them from turning. A chuck fitted up

in this way is as good as new, possibly better.

## STRENGTHENING THE CHUCK WRENCH

Ever since I have been connected with machine shops we have always had trouble with the chuck wrenches — that is, the wrenches for the lathe chucks. They usually break in the corners when hardened and wear out when left soft. I have a little kink which helped us out

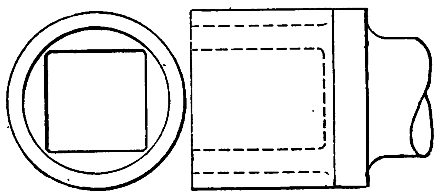


Fig. 11. — Strengthening the Chuck Wrench.

of our trouble: Turn down the end which has the square hole in to about $\frac{1}{32}$ inch from the corners and force a tool-steel bushing on. The wrench will last indefinitely. We turn the end down, as shown in Fig. 11, and case-harden. We use soft steel and fit the bushing on afterwards,

We have sometimes not more than $\frac{3}{64}$ inch on a side.

## REPAIRING A PLANER HEAD SWIVEL BOX

We had a breakdown in one of our planer

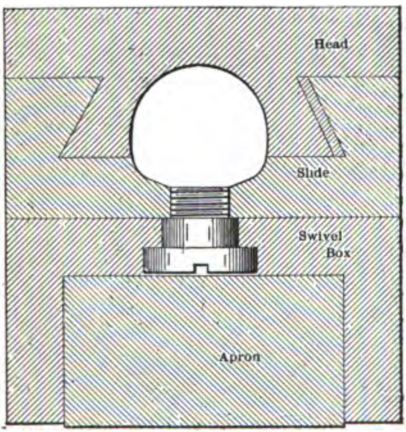



Fig. 12. — The Way it Wore Out.

heads recently, and it was due to the new method that is being used by some planer makers.

The apron swivel-box center pin is made 1 inch diameter, has 14 threads per inch and has only $\frac{1}{2}$ inch of thread, which screws into the cast-iron

slide. This stud, as shown in Fig. 12, bears most of the strain when the tool is cutting and was not long in wearing loose in the threaded hole, due to its small diameter and fine thread and very short bearing, and finally completely stripped the thread and smashed the swivel box.

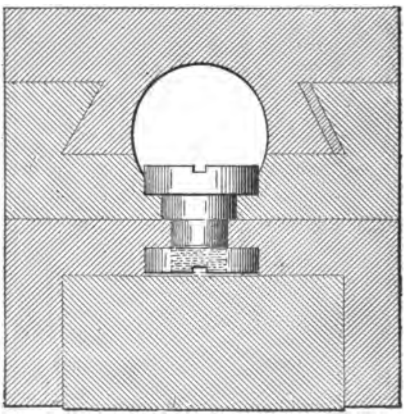


**Fig. 13. — How it Was Repaired.**

Fig. 13 shows how head was repaired by putting on a new box and making both stud and nut of steel.

The older, better method is to turn a fair-sized boss on the back of the swivel box, and have it

fit into a hole in the slide. The boss then takes the thrust and not the center pin, as Fig. 12.

## AN IMPROVISED HOIST

I WAS once called upon to suggest some practical way to take down and put up a heavy line of shafting, about 150 feet long, having a large number of pulleys ranging from 2 to 5 feet in diameter. It was the main shaft for a woodworking plant. There were no pulley blocks or tackle of any description to be had, and this shaft must be taken down, some pulleys removed, others put on, and be back in place between quitting time Saturday night and starting up time the following Monday morning. This line of shafting and its pulleys would weigh several tons, and without tackle it seemed quite an undertaking. I had very little time to consider the matter, being on my way to the railroad station to take a train, but suggested the following described plan, which proved a success, the proprietor assuring me that it was better than any blocks or tackle he ever used or heard of.

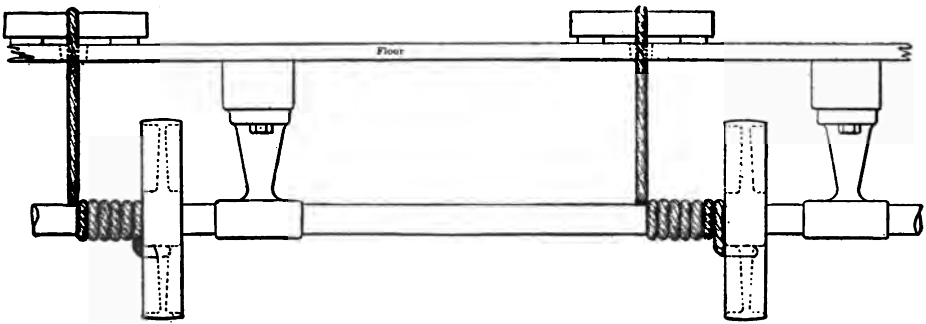



FIG. 14. — Improvised Hoist for a Line Shaft.

My recollection is that they used six pieces of rope of suitable length, 1¼ inches diameter; one end of each rope was made fast to an arm of a pulley — these ropes being located as nearly equidistant as the pulleys on the shaft would permit — then each rope was snugly wound around the shaft until enough in length had been wound so that when unwound they would allow the shaft to reach the floor, or other arranged support.

The other end of each rope was then passed up through a hole cut through the overhead floor, and made fast to a piece of timber, these timbers being shimmed up so as to make all of the ropes as nearly uniform in tension as conveniently possible. Of course the holes through the floor were located directly over the point where the loose end of the rope left the shaft. Then all the caps to the hanger boxes were removed and six men rotated the shaft by the rims of as many pulleys in the direction to raise the shaft out of the boxes, when two other men, by using levers, swung the shaft clear of the boxes; then the men at the rims of the pulleys

let the shaft rotate in the direction to unwind the ropes from the shaft, as in Fig. 14, which, of course, lowered the shaft with perfect ease and safety. Of course the raising of the shaft was simply a reversal of the action of lowering. A portion of this shaft was 4 and the balance 3 inches in diameter, and they wound some old sacking around the 3-inch, so as to make it 4 inches where the rope was coiled on it. Of course they had to arrange something for the men to stand on, as they could not reach from the floor.

I have used this plan several times since very satisfactorily, and in doing so have not as yet found anyone that had ever seen or heard of its use before, which indicates that it is not generally known, though, of course, so simple a thing must have been used.

## HANDLING SHAFTING WITH ROPES

THE method shown in Fig. 15 is very handy in many cases. It has economy, ease and constant safety to recommend it. If there is only

one pulley on the shaft, two safety lines may be used, one at each end, and the rolling hoist rope in the middle.

If the piece to be hoisted is exceptionally heavy and lacking a pulley large enough to serve as a hoist lever, any bar or piece of timber may be used as shown by Fig. 16. If the center hoist

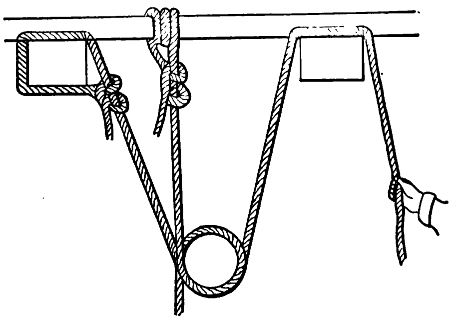


FIG. 15. — Lowering with Safety Ropes.

and two-end safety-line way is used, with a bar or even a pulley, try to make it work centrally, as shown by Fig. 17.

Where an extra large and heavy pulley countershaft is to be hung on a very high ceiling and rolling must be resorted to, for lack of head room or suitable tackle, the inadvisable, because most

hazardous, rolling from ladders can be done away with as in Fig. 18. The hangers being up, place the stripped shaft in the bearings and adjust the collars. Tie a rope's end to the pulley on the floor, pass the other end over the shaft, run a

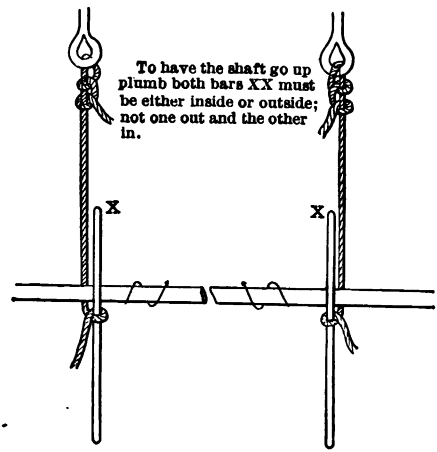



FIG. 16. — Hoisting with Two Ropes.

bar through a bow-line in the rope and hoist the pulley to the staging from which the counter was put up. When everything is on the scaffold take the shaft out, assemble the counter and

hoist it into place the rest of the way in the regular manner.

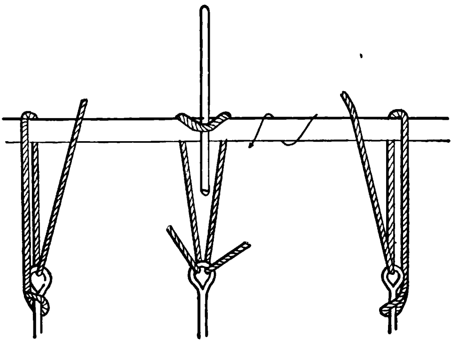


FIG. 17. — One Hoist and two Safeties.

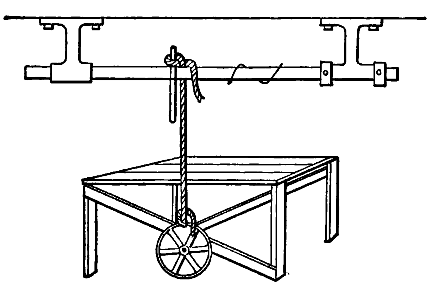


FIG. 18. — Hoisting with Scaffold.

## KNOTS AND HITCHES

FIG. 19, made by two endless slings and used as shown in Fig. 20, is a reliable basket hitch when both slings are of equal length, or with one sling long enough to take in one-half of the cylinder's diameter and the other to run through both loops of the smaller and have its own loops catch the chain hook.

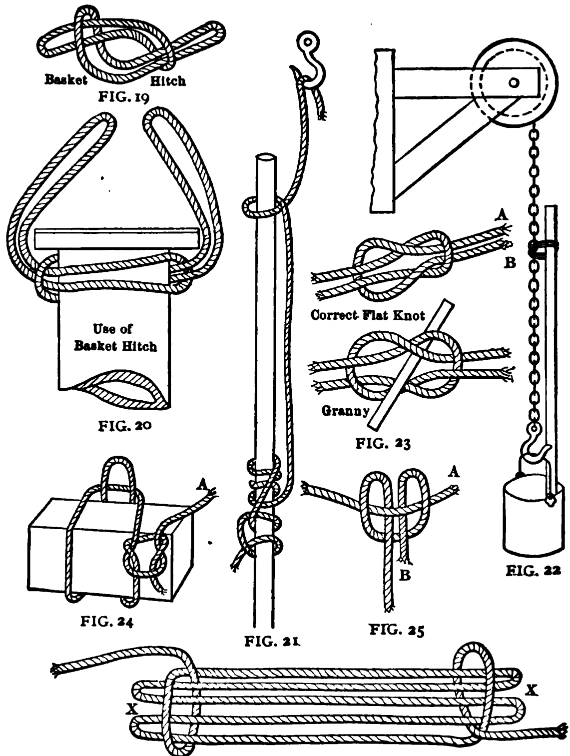
Some people hoist a shaft endwise by using a collar or lathe-dog as a safety stay; others use the bitting-rolling hitch shown in Fig. 21, but in one conservative concern whose screw and bolt department, on the fifth floor, is provided with an independent hoist chain, they use the rig shown in Fig. 22. The bucket is hoisted above the floor level and then pulled in as the hoistway is reversed and made to lower away.

It is a very common practice, in the absence of a ready-made endless sling, to tie a flat knot in a short length of rope and use it in lieu of a sling. Be careful to avoid a "granny knot," Fig. 23, which is unsafe and which we all know about; but there is another fool trick that can

easily be played with this knot, and I was just chump enough to work it. As it may be new to some of my readers, I will tell you how to get into my class. We were lowering a bed-plate, and as it was going down, to help keep it clear of the building, I took hold of *A*, Fig. 23 (you might take *B*, for a change) and gave it a good, strong pull, and down came the bed-plate with a rush. I was too busy saving the pieces just then to figure it all out, but I have since worried it out to this: My pull at A, Fig. 24, caused the loop to double back, as shown in Fig. 25, and then the weight of the bed-plate pulled *A* out of my hand, through the doubled loop, and, presto! the trick was done. In making a flat knot with chains, a piece of pipe or wood should be run into it, as shown by Fig. 23, to prevent jamming.

Fig. 26 shows a good and safe way, known as a sheepshank, of shortening a long rope. It is self-evident that any amount and any length of loop may be used, but it must be carefully borne in mind that at least a 6-inch length of overlap loop at *X X* is essential to absolute safety.

The next is made without passing the end,




Knots and Hitches.

and provides two loops to which a tackle block can be hooked. Fig. 27 shows the start; Fig. 28,

the second stage; Fig. 29, the manner of rolling the two loops into the standing portion of the rope, and Fig. 30, the two loops *X X* brought vertically down (after rolling) and ready for service. The block or fall must be hooked into *both* loops. The above is a safe and reliable hitch that can be wiggled in at any point in a rope, and besidés being perfectly reliable, it is easily and quickly made and unmade.

Fig. 31 is an old and well-known friend of the rigger, but machinists should beware how they use it on Friday, as it has been known to betray a trust.

Fig. 32 is a simple and safe way to take a temporary hold, but as the mere shifting of the weighted loop will suffice to loosen the whole rig, the need of keeping meddlers away must be obvious.

Fig. 33 shows how in using a chain block, whose hoisting and lowering range is necessarily confined to the limit of its chain length, the weight may be raised or lowered to any distance. Thus in Fig. 33 the chain travel is only 10 feet, but the weight has to be raised 20 feet. We lower the chain and hook into the rope at *A*,

hoist the 10 feet and make the free rope's end *B* fast to any convenient projection overhead (if necessary, even to the chain block's suspending hook *C*). We now unhook and lower the chain again for its new *previously prepared hold* lower down, as at *D*, and up she goes, the 20 feet, or any other old distance. We emphasize *previously prepared hold* advisedly, as, if not so prepared, it will be found impossible to wiggle in a hold for the hook in the tautened rope. Fig. 31 cannot be used for second holds, and positively must not be used as a starter, or first hold, because, after fastening at *C*, it will be found both hard and dangerous to slip the hook out of it.

Either the doubled-up, non-slipping loop, Fig. 34, or bow-lines should be used all along the line.

Speaking of bow-lines, the slack line *X* may go either in front or back of the standing rope *Y*, as shown in Figs. 35 and 36; but in either case, after going around *Y*, it must be passed through the loop *Z* in the manner shown in Fig. 37. Passing it through as shown at Fig. 38 cuts out the non-slipping feature and reduces the bow-line to a farce.

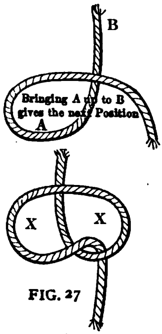



FIG. 27

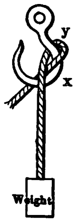



FIG. 31

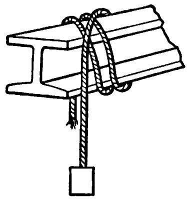


FIG. 32

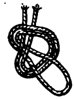


FIG. 34

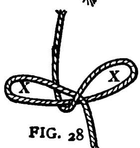



FIG. 28

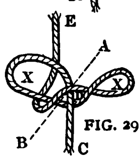



FIG. 29

The first turn of the loops XX should bring rope end C through loop D. Two more turns upward should then be taken along cross A B.


FIG. 33

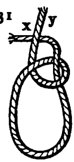



FIG. 35

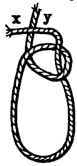



FIG. 36

FIG. 37

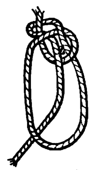


FIG. 38

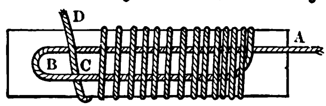



FIG. 39

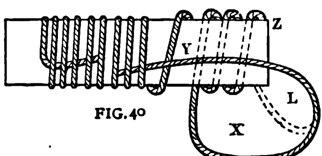



FIG. 40

FIG. 30

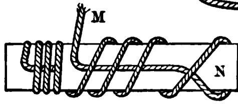



FIG. 41

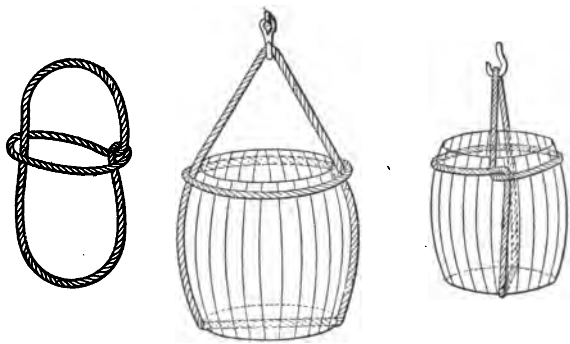
A broken hammer handle, a split monkey-wrench handle, etc., may be nicely repaired by the endless-wound splice, Fig. 39. The make-up is, we think, pretty clear as shown, and it is evident that by pulling at *A* the loop *B* will make a similar loop in *D* at *C*, and that continued pull will draw the crossed loops out of sight. The loop ends may then be closely cut off.

Fig. 40 is preferable for extra neat work, in that it does away with the bulge caused by the crossed loops. Until the loop *X* is got to all is plain sailing. The rope *Y* must then be held steadily in its place on the stick *Z* while the loop is swung around both it and the stick, as shown by the dotted outline. Only at the finish (shown in Fig. 41) should *Y* be allowed to move. Then it, as a part of loop *L*, should be swung round the stick as shown at *N*. Setting the coils close and drawing up at *M* completes the job.

Always, and above all, in using ropes do not abuse them. Bagging, burlap, even waste or paper, if the first are not to be had, should always be interposed between a rope and all hard, angled, even if not sharp, edges.

## SLINGING A BARREL

It is often necessary to sling a barrel containing small castings or liquids. While with both heads on and the bung in place this is an easy job, but with one of the heads out it is amusing to see



Figs. 42, 43, and 44. — Slinging a Barrel.

the amount of rope the average landsman will take to lash the barrel in such a case. The illustrations 42, 43 and 44 show how this can be done with an ordinary sling.

## SAFE GRIPS FOR HOISTS

To give chain tongs their first safe hold as a

basis for future self-gripping in direct proportion to the load applied, they need jabbing in. Hence we now make a pair of tongs as per Fig. 45. The tightening clamp *A*, safely held in place on the tongs proper by the slot, enables us to do away with the *jabbing* and substitute the far more effective *jamming*. A few good taps at *X X* while tightening the clamp are a great help.

Where the beams run to a uniform thickness of 3 or 4 inches, the clamp, Fig. 46, is quick, light and sure. We are lifting 2 to 2½ tons regularly on each style, and, though both effective, we, on account of handiness, prefer Fig. 46.

## WOODEN BEARINGS

I HAVE often heard millwright wiseacres talk of the effectiveness of substituting wood bearings in emergency cases, and took but little stock in what I deemed their yarns, until it fell to my lot, a bearing having burned out, to get a countershaft running again in a hurry or own myself beat. The shaft was $1\frac{15}{16}$ inches diameter, running 180 revolutions per minute, transmitting

about 15 horse-power and driving with a down belt.

I fell back on two 4 x 4 x 8 inch pieces of yellow pine, gouged them out roughly with a chisel (hadn't either expansion bit or auger handy), soaked them in oil for a couple of minutes, buttered them up with grease and black lead and put them into the hanger, as at Fig. 47. To have kept that shaft running I would gladly have gone out and bought it drinks, but it was not necessary. During its three days' go a little castor oil every two hours was all it asked for.

To try an experimental machine it was desirable to put an 8-inch split wood pulley on the main shaft. Easy enough, but not with the shaft running. "I'd like to try the machine before the boss comes," said the draftsman, "but unless it can be managed without giving me away by stopping the shafting we will have to let it go; can you help me?"

I was not sure, but tried and, dumb luck favoring, succeeded. First, the pulley was put on the shaft and screwed together without the bushing, then the two quarter bushings 1—2 were

put in the bottom half. The other two quarter bushings having one end beveled off, as shown at *A*, Fig. 48, were put into position shown in

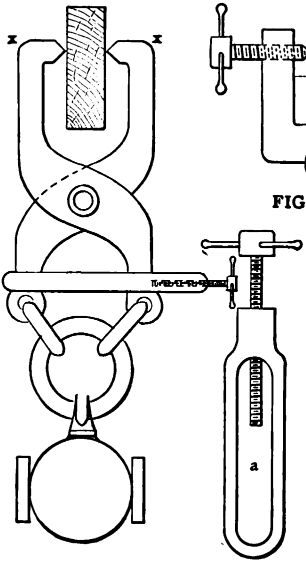



FIG. 45

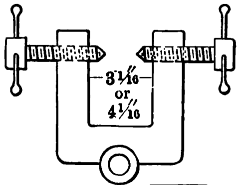



FIG. 46

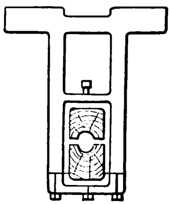
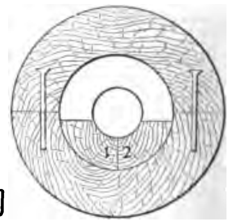
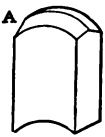


FIG. 47





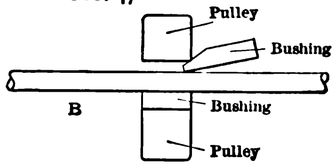




FIG. 48

*B;* a sharp tap entered the bushing partly, and while the pulley was so running the bushing was tapped in with a mallet the rest of the way.

A light machine had to be driven at a speed so

slow that an addition of one-half to the main shaft diameter would drive it. A ball of light twine was run on the strap while at the same time a bar of belt dressing was used to hold each successive layer firmly in place.

Often, when in need of a flat pulley, only a crown pulley will present itself. Now, we all know of several ways to crown a flat pulley, but when a friend of mine proceeded to flatten a crown pulley (wood) with a rasp, the obvious simplicity of the thing almost killed father.

## A CRANK-PIN REPAIR JOB

THE crank-pin on the engine had been giving trouble for some time. It was decided to take it out, straighten the hole and put in a new pin, and, as usual, this had to be done on Saturday night so as to be sure to have it ready to run Monday morning.

Not expecting it to come out very hard, we chipped off the riveting from the end of the crank-pin, then took five heavy pieces of machine steel and two 1½-inch bolts, applied them as in

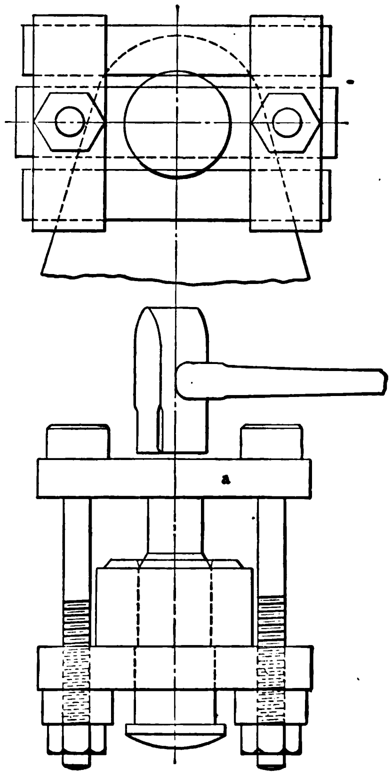



FIG. 49. — Getting the Crank-pin Out.

Fig. 49, putting a short piece of 3-inch shafting between clamp *A* and the end of the pin, screwed up our bolts as tight as a 3-foot wrench would do it, at the same time using a 20-pound sledge as a persuader, and after a little forcible urging along this line Mr. Crankpin concluded to move.

The intention was only to scrape the hole; but after the pin was out we found it so bad that we had to drop the idea of scraping and find some other more aggressive way of truing it. Picking up two unfinished air-hoist heads, we faced them off and bored them to fit a boring bar we had around the shop; put these on the crank as shown in Fig. 50, using a pair of 1-inch parallel strips as distance pieces, and a No. 3 Renshaw ratchet for turning and feeding the bar. To keep the cutter from slipping ahead we blocked a jack-screw, which just happened to be handy, between an arm of the fly-wheel and the other end of the boring bar, feeding the screw back as the boring bar with the cutter went ahead. In this manner we succeeded in getting a good, straight crank-pin hole in a very short time. There certainly are better means for doing jobs

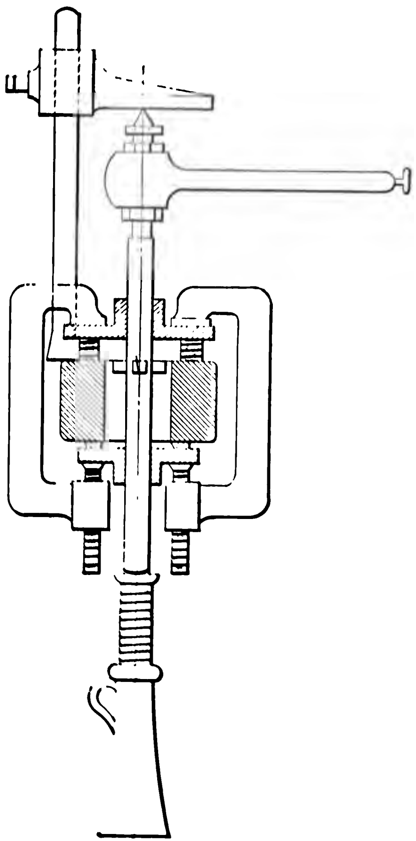


FIG. 30.—Reboring Crank-pin Hole.

of this kind, but this is a good way when you have no other means at hand.

## REPAIRING A CRANK-SHAFT

An 8-inch diameter crank-shaft of a center crank engine with a very loose crank-pin was the trouble. I was asked if I could put in a new pin and guarantee the shaft to run true without taking a cut off the journals. At first I said no, but after a time changed my mind and offered to do the job for a good, fat price if satisfactory, and no charge if not. The manager did not have as much confidence in my ability as I have, but after some talk we made a start. That evening, a friend of mine, who has had a very wide experience among the big engine builders of our smart cousins across the line, stopped me on the street and told me that I was running up against the worst proposition that I ever undertook, and that I was doomed to fail. This did not scare me, however, and I went at it.

I took out the old pin, bolted the two crank disks together with three distance pieces the same

length as the crank-pin between them, put the shaft in the lathe and filed and fitted the distance pieces until the shaft ran absolutely true. While this was under way I had four rough castings made to serve as temporary bearings, planed the bottom side of each to fit the shears of an old lathe and placing them on the lathe bed I swung the shaft out of the centers and blocked it up on the old lathe bed with my four castings under it, one under each end and one close up to each disk, then ran cheap babbitt under the shaft into each of the four castings. When these were cold the bearings were scraped to a fit and the shaft was strapped down.

The next move was to rig up a temporary boring bar, set as nearly parallel with the crank-shaft as possible, and bore the two holes at one setting. We then removed the boring bar, clamps, distance pieces, etc., and shifted one part of the shaft with its two bearings end-wise on the old lathe bed, turned a new pin and pressed it in with a 100-ton hydraulic jack, two strong backs and four rods, the two sections of the shaft all the time resting on the

bearings and the bearings resting on the lathe bed.

The shaft was then put in the lathe, was found to be straight and true and was turned over to the owners. It ran cool, the pin is still tight and we got our money. Fig. 51 shows the repair.

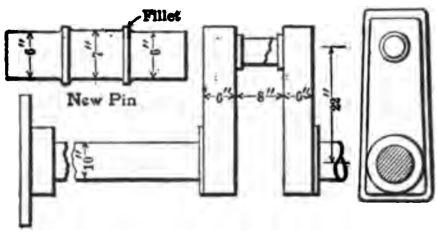



FIG. 51. — Repairing Broken Crank.

## A BROKEN CRANK

A WHILE ago I helped, in a Southern city, on a repair job, a sure hurry job. The crank-pin in a center crank ammonia compressing engine broke one Friday afternoon in August, and as the city's supply of ice was furnished mostly by the plant, it was quite necessary to get it going

as soon as possible. The sketch will show how the job was done and suggest some of the troubles one might have in doing it in a shop where modern tools were scarce and where the men were unaccustomed to heavy work. See Fig. 52.

The old crank-shaft was a single forging, nearly alike on both ends, with a coupling flange on each end. We planed off all of both pieces of

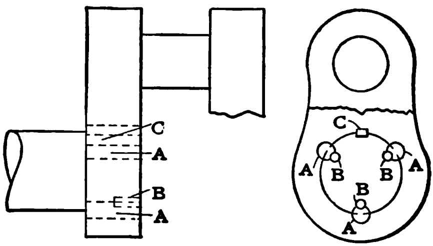



FIG. 52. — Crank-shaft Repair.

the broken pin, just truing the inner faces of the crank webs, and the two parts were securely bolted together and a 2½-inch hole was first drilled as a starter for boring the pin holes.

After the cranks had been bored to the proper size, bands made of 2½ x 5-inch stock were shrunk on. The two parts of the crank-shaft and the

pin were then taken to a railway shop that had a wheel press and pressed on to the pin, both sides being pressed on at the same time.

The crank-shaft was then replaced in the engine frame, coupled up, and, for aught I know, is as good as new — probably better, as the main bearings do not heat as before the breakdown.

We had some difficulty in finding a piece of steel large enough for the pin. A piece was procured (by express) from Cincinnati. No lathe in the shop would swing the crank with what blocks we had, so temporary ones had to be made to help out. The bands not being of exactly the same size, the shrinking on the cranks made the holes for the pin different sizes, one of the holes being drawn about $\frac{1}{32}$ scant out of round and the other full $\frac{1}{32}$ inch.

It took about 45 tons for one side of the pin and 53 tons pressure for the other.

## A CRANK-SHAFT REPAIR

I HAVE seen the use of the short spanner and heavy hammer for tightening up nuts on bottom-

end bolts of marine engines severely condemned.

As a practical machinist and engineer, with thirty-five years' experience on locomotive, marine and stationary engines in large shops with modern tools, in small shops with some tools, in the backwoods with a claw hammer and a broken file, I think that I am in a position to express an opinion on the subject.

I have tightened up 5-inch bolts in bottom ends and main bearings on board ship and would hate to undertake the job with a wrench long enough to do the work properly, as I am afraid that one end of the wrench would be in the stokehold or out on the wharf. I have seen hundreds of $\frac{7}{8}$- and 1-inch follower bolts in locomotive pistons strained or broken by the injudicious use of a socket wrench and tommy bar, but have yet to hear of a similar occurrence on large bolts set up with a short wrench and hammer. It all hinges on the man who does the job.

This brings to my recollection a repair job that was done on a marine crank-shaft, that should be of general interest.

The 10-inch crank-shaft of a fore-and-aft compound engine was reported as having the after l. p. crank web loose on shaft. As it would have cost considerable money and time to remove the shaft and repair it, the following plan was adopted. To the best of my knowledge the shaft is still in service and has given no more trouble.

Three 1½-inch holes were drilled and reamed with a taper reamer, ⅛ inch to the foot taper. Tool-steel plugs were then turned to the same taper as the reamer and small enough to enter in the holes about 2 inches. The plugs were then eased off on two opposite sides and forced into the holes with jack-screws and wedges.

The final operation was to drill and tap three ½-inch holes 3 inches deep, half in each plug and half in the shaft, into which screwed plugs were fitted and cut off flush.

## REMOVING LARGE CRANKS FROM THEIR SHAFTS

LARGE steam-engine cranks sometimes have to be removed from their shafts while the latter

are in their places. When tackled properly this job is not such a task as it appears to be, although it requires the exercise of a certain amount of care and judgment. The cranks are, as a rule, shrunk on, and therefore have to be heated to expand the bore to take them off. I have used various ways of heating them, according to the situations in which they are placed, sometimes using a specially constructed portable forge and sometimes powerful gas heaters and a portable blower. When the crank is being heated, however, the shaft must be kept as cool as possible to keep it from expanding also. The sketch Fig. 53 shows how we effect this by a water jacket, which is a cylindrical pipe with a blank end cast on, the other end having a flange about 1½ inches broad, faced true to fit against the shaft end, the joint being made by an asbestos washer. *C* shows the water jacket in section, held to the shaft end by a bolt *D* passing through the jacket and screwed into the center of shaft end. *E* is the inlet pipe for cold water — coupled to the town supply. This pipe carries cold water to the shaft end as shown, and it circulates away

through the pipe *F* at the top. When the crank is expanded enough, the water is let out of the jacket by a small cock at the bottom, not shown; the bolt is slackened, the jacket taken off and the crank pulled off, being slung in pulley-blocks.

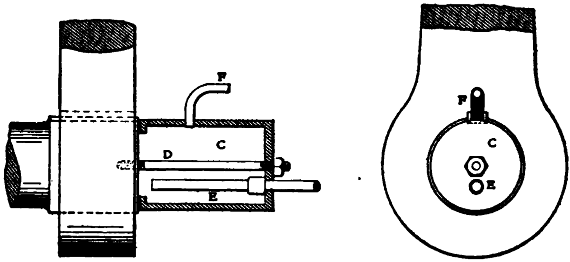



FIG. 53. — Removing Large Cranks.

## REPAIRING A HEAVY CRANK-SHAFT IN A SMALL SHOP

THE crank-shaft of a good-sized engine broke down, and as usual it was needed in a hurry. One crank-pin had broken where it was let into the cheek of the crank, and the size can be judged from the fact that the pin was 8 inches in diameter and the whole shaft weighed 5000 pounds.

It was a double-throw crank, as shown in the sketch, the pins being reduced where they went into the cheeks, and the broken end remained in the cheek. This was bored out with considerable difficulty, in the biggest lathe in the shop; but the interesting part was forcing in the crank-pin with the facilities at hand.

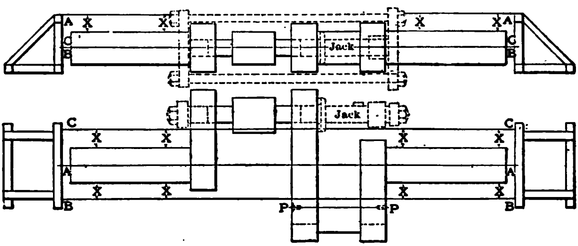



FIG. 54. — Repairing a Heavy Crank-Shaft.

The shop is on the second floor of a large building and has no regular forcing press. So the two pieces of the shaft were blocked up from the floor a little, the 2-inch steel bolts used to strap a jack against one cheek as shown, and the rig for forcing in was ready. See Fig. 54.

But it is one thing to force a crank-pin in and quite another to have it true, and it

would be hard to say which is the more important.

A stand, or frame, was fastened to the floor at each end of the shaft as shown, and three lines of fine piano wire *A A*, *B B* and *C C* stretched at equal distances from the main parts of the shaft. Using these as guides, the two end bearings were lined up by measuring at such points as *X X* in both views, and then the forcing in was commenced.

Measurements were taken at frequent intervals and any tendency to get out of line was at once corrected by applying a little outside pressure at different points. This corrected both "cocking" and "twisting" errors, and when the crank-pin was finally home it was true in all directions within very close limits.

A hole was then tapped so as to be half in the cheek and half in the small end of the pin, as at *P*, as a safeguard against turning, as they are not anxious for this job every day.

## BORING A CYLINDER BY HAND

THE cylinder to be bored was about 5 feet

long in the part to which the liner was to be fitted. The original diameter of the bore had been 10 inches. We intended to bore it out to 11 inches and put in a liner an inch thick. I found an old shaft, 7 feet long, that I turned up to 3 inches. Two glands bored to fit it and turned up on the outside made very good bearings, and two pieces of flat iron, 8 inches wide, 2 feet long and an inch thick, were just what was needed to carry the bearings. These pieces were faced on one side and a hole was bored in the center of each for the gland. The pieces were faced around the hole on the other side far enough to give the glands true bearings. A flange did very well for a cutter head after it had been bored to the size of the shaft and a set-screw put in; a shallow groove served to keep the tool from moving, while a couple of studs and a strap kept it in the groove. See Fig. 55.

For a feed, all that was needed was a piece of flat iron with a tapped hole in it and a piece of round iron about a foot long, threaded to fit; one end of this piece was squared to receive an old valve handle, while the other end was ground

to a point to go into the center of the shaft. One end of the bar was turned down and a gear 18 inches in diameter fitted on. Enough room

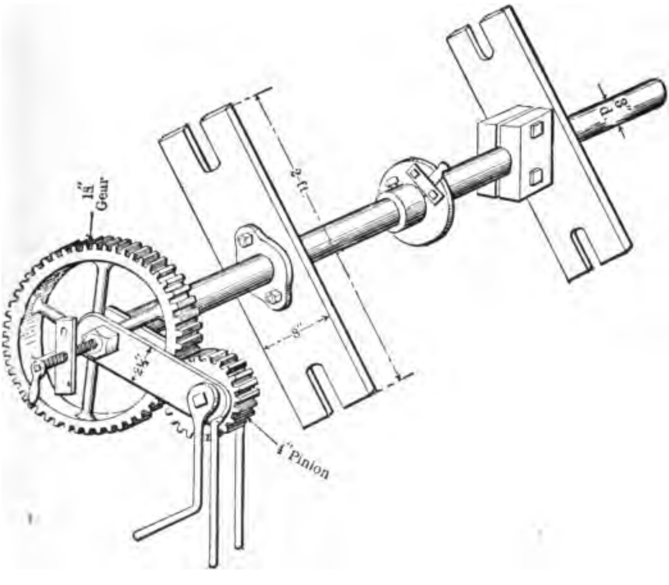



Fig. 55. — Hand Cylinder Boring Rig.

was left on each side of the gear for a piece of flat iron. A pinion 4 inches in diameter worked with the gear. The pieces of iron had holes

bored in them the size of the holes in the gear and pinion, and the same distance apart that their centers would be when they were in proper mesh. The spindle for the pinion was long enough to allow of one end being squared to receive a crank, while a couple of pins held the flat pieces in place. A piece of flat iron riveted to each flat piece near the outer end served as a support to hold the pinion the right distance from the floor to allow of easy working. Now, all that was needed was a couple of pieces of wood that could be clamped to the bar with a couple of bolts, as a drag to keep the bar from feeding too fast, and a piece of board to fasten the feed to. It was safe enough to risk getting the board and some nails at the refinery.

It did not take long to get the cylinder unbolted from the bed and the bar run through, the head slipped on, and the flat pieces bolted across the ends. A little care in setting, and the bar was in the center of the cylinder, ready for business. It was only intended to give the liner a bearing on the ends, so the center of the cylinder

did not need to be any particular size or shape, so that it did not interfere with the liner going into place. This made the job much more simple. The first work was to get the extra iron out, and at first we tried with both boys at the crank at once; then we tried with one boy at a time. This meant work half the time and rest half the time, and was much the quickest way. The boys both said it was also much easier for them, so we worked it that way all through the job.

The hardest part of the job was getting a smooth cut when we came to finish. The bar was inclined to spring if the cut was not just right, while the feed had to be regulated by the movements of the boys, and not by whistling some nice, soothing tune, such as could be used when a machine was doing the pulling.

As the board that held the feed works had to be moved along every few inches of cut, we went down nearly to size before moving along. The bar was not long enough to bore entirely through without resetting the cutter-head, but finally the stock was worried out. Before starting the finishing cut I went over the setting of the bar

very carefully, to make sure it was in the center of the cylinder. In roughing out the cylinder, one end — the end that went toward the steam cylinder — had been left a little smaller than the rest of the bore. This small end was finished first and was left small.

The head was then slipped to the other end of the bar and that end was bored for a length of about 5 inches, which was the length of the finish on the small end. That gave a true spot in each end and the center was large enough to allow a piece the size of the small end to pass through it freely. A piece of wire fitted to each end made a nice gage to turn the liner to. A little observation of how everything around a water pump rusted up set at rest any fears that at first bothered me about having that liner a good-enough fit. I saw that nature would take care of any reasonable fit, even if our old lathe didn't turn or bore exactly straight or round, and, after reboring a cylinder that was more than half an inch larger in the center than it was at the ends, I was not afraid of any fault-finding with the inside of the liner.

## REBORING A LOCOMOTIVE CYLINDER WITH AN AIR DRILL DRIVE

It is, I believe, common practice in locomotive shops, when an engine comes in to be repaired, to rebore the cylinders without taking them off the engine, which, of course, necessitates a special rigging or fixture. If all the shops do not follow this practice, we do, and have done so for years. Heretofore we have used a movable stand with a pair of tight and loose pulleys, but a few days ago, for some reason or other, that rig was out of commission and an air drill was put into service. This proved very satisfactory as long as the pressure was even. Of course at times there would be more air machines, drills and hammers in use than at others, which naturally affected the speed and power of the drill that we used on the cylinder; but as only very light cuts were taken it did not bother us much in the way of power. We used a No. 0 (or size 0) Little Giant air drill, which at 80 pounds pressure produces 3½ horse-power, the spindle making 150 turns per minute.

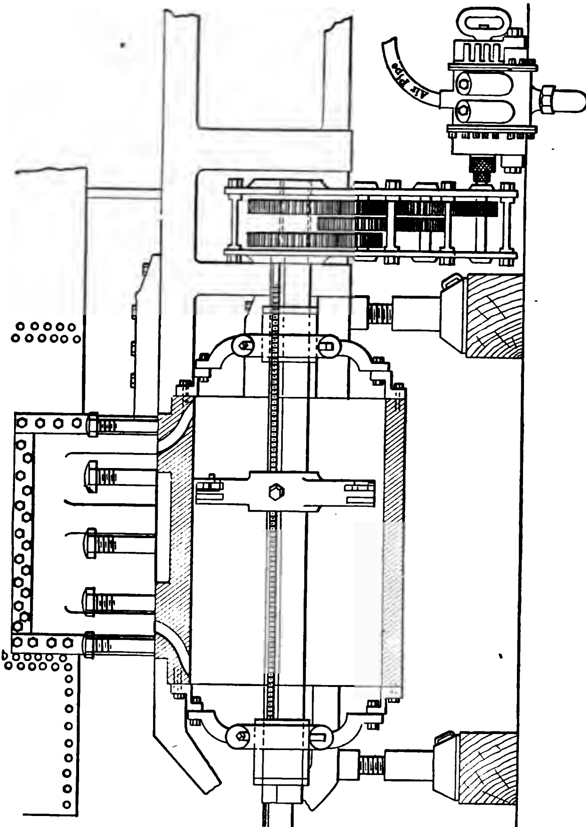



FIG. 56. — Reboring Locomotive Cylinder with Air Motor.

The accompanying sketches will for the most part explain themselves. Fig. 56 shows the forward part of the engine held up by four jacks, two on each side, the forward wheels having been removed to be turned. The cylinder is shown in section in order to show the boring bar and arm in working position. The bar is driven by the train of gears, as shown, reducing the speed at which the spindle of the air drill revolves, which is 150 revolutions per minute, down to about 10 revolutions per minute for the bar. The air drill is shown connected to the shaft of the first pinion merely by a socket.

The boring arm or star is a single casting with two places planed or slotted in to hold two pieces of steel *B B*, Fig. 57, which act as gibs, these being adjusted to the bar by the screws which back them. Opposite these pieces is a place cored out for a brass nut through which the feed screw goes. There is also a hole drilled in the casting itself which helps to steady the screw. At *y* is shown a tool-holder and a tool in position. One arm is left free in the drawing to show its shape more plainly. It will be noticed

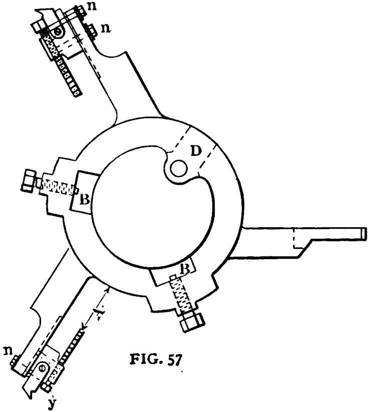
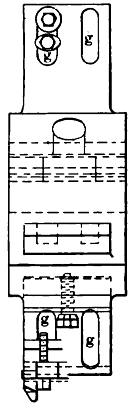



FIG. 57



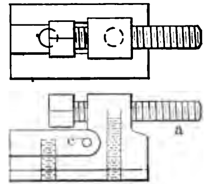




FIG. 58

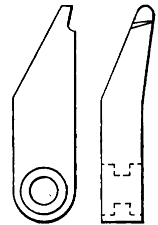


FIG. 61

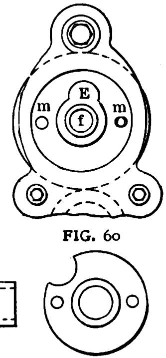



FIG. 60

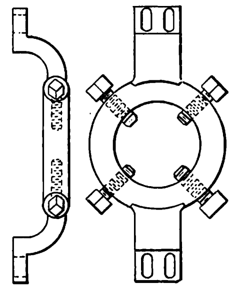


FIG. 62

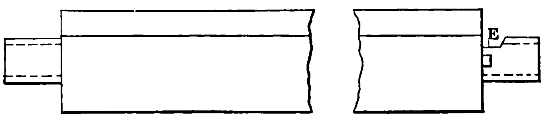



FIG. 59

Details of Cylinder Boring Bar.

that the faces of these arms are set a certain distance back of the radial line; this is to bring the tools on the line. The tool-holder is bolted on to the arm by bolts running up through the slots *g* and screwing into the holder or block, as shown. The tool is in form like any common "rooter," only slightly bent, as shown in Fig. 61, with a $\frac{3}{8}$-inch hole drilled in the back end and counterbored, through which a screw bolt passes, going through hole *c* in the block with a nut and check-nut on the other end. The screw *a* is merely to take the strain off the clamping screws *n n n* by tightening up against a block put in place marked *A*. By means of this it is also easy to move the tool out a very little at a time to adjust the cut.

The boring bar is merely a round shaft with a groove cut in it for the screw, the ends are turned smaller and one end is bored or drilled and in this goes a gear which meshes with a gear on the end of the feed screw which goes in place marked *E*, the center gear being held from turning; consequently, as the bar rotates, the gear on the feed screw travels around the center

gear, thereby causing an independent movement of the screw which, consequently, causes the boring arm to travel from one end of the bar to the other; there are two pins driven into and projecting from the end of the boring bar (see Fig. 59) which fit into pin holes marked *m m* in the gear plate, thus acting as keys or drivers; the shaft or spindle on which is the stationary gear *g* is independent, so that when it is desired to run the arm back and forth on the bar the spindle is released by means of a clamping device not shown, and a hand-wheel is slipped on the back end, and when desired to put the power feed on it is merely clamped tight again.

The bar runs in two sleeves which are held in place in the two end brackets (Fig. 62) by adjusting screws as shown.

## REPAIRING A CRACKED FLY-WHEEL

A FEW years ago while working in an engine shop in Yorkshire the boss sent me — then only just out of my apprenticeship —, along with another workman about the same age, to a woolen

mill a few miles away, where a flaw had developed in the fly-wheel of the mill engine in the shape of a crack in the boss, as shown at *A* in the sketch. Our instructions were to "hoop" the boss, as shown at both sides, with steel hoops. It looked a herculean task to begin on, but it was successfully accomplished in about eight days' time,

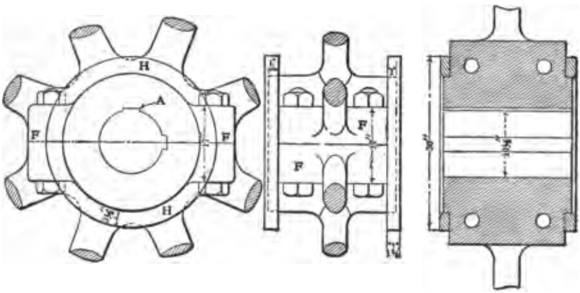



FIG. 63. — Repairing Cracked Fly-wheel Hub.

and the wheel is runing quite safely to-day. As it was a somewhat difficult job to perform — entirely by hand — and also a job not encountered very often, a few particulars as to how we proceeded will be of general interest.

As will be seen from Fig. 63, the fly-wheel was cast in halves and secured by bolts passing

through lugs projecting from each side of the boss, which had two keyways cut in, as shown. A crack had developed in the top keyway, as shown, and it extended across the boss in such a manner as to cause some uneasiness to the owners, who did not want to go to the expense of a new fly-wheel.

The bolt lugs *F* were cast flush with the face of the boss and were 17 inches wide, the boss being 23 inches diameter. We had to chip 1 inch off the edges of these lugs and finish off the boss here to their circle 23 inches diameter. It should be mentioned that we could not chip more than the 1 inch back on account of the nuts. The wheel ran along the side of the engine-house wall, so we had to sit in the wall box, about 24 inches high, to chip that side nearest to it. It was a tedious job, as we had to use a short-handled hammer, not being able to use an ordinary hammer on account of the wall box top. We got the chipping done, however, and a fairly true circle was made for the hoops, 23 inches diameter by 1 inch thick. Our next job was raising the fly-wheel and shaft,

which together weighed about 24 tons. This we did with hydraulic jacks and packed the lot up with timbers under the fly-wheel rim. We then had to remove the crank to get the hoop on to that side of the boss, and to do this we used two large gas jets placed directly under the crank and coupled two air pipes to a small portable fan we had, turned by hand. We got the crank off all right and the hoops on, these in the mean time having been made and turned at the shop to gages we made. It will be seen that the hoops were $1\frac{3}{8}$ inches thick, although only 1 inch on the boss, the other $\frac{3}{8}$ inch overhanging on the outside and beveled off, as shown in section. By this means we got them much stronger in sectional area. We gave the hoops plenty of "nip," allowing nearly $\frac{1}{16}$ inch to shrink on, *i.e.*, making them $\frac{1}{16}$ inch less in bore than the boss was in diameter. To get them on we had to get them red hot, but when they got on they soon closed and fastened themselves tight on the boss, which they held firmly, and thereby prevented the crack from going any farther. The job was a success in every way; since then the wheel has

been speeded up 10 turns per minute, and is working quite safely.

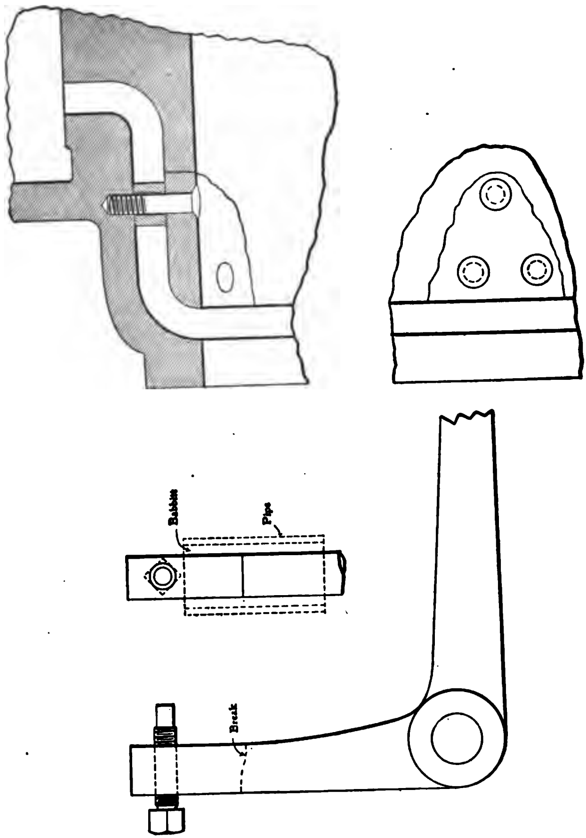
## GAS ENGINE AND CYLINDER REPAIRS

SEVERAL years ago I took charge of a small Western job shop, and among the odds and ends about the place was an old gas engine used to furnish power for the cupola fan. One feature of the engine was a cast-iron bell-crank operating the exhaust valve. While taking off a heat one day this casting suddenly broke, and it looked for a while as if the heat would certainly be lost. It was not, however, for the casting was patched (in somewhat less than 10 minutes by the watch) in the following manner: As shown in Fig. 64, the casting had at least 2 inches of clear space on each side of the break. It took but a few moments to slip a piece of pipe over the break and fill it with babbitt which was melted by placing the ladle in a puddle of iron.

Were you ever called out on a nice Sunday job of flue rolling on a "red-hot" traction engine? This isn't so bad until it comes to rolling

$2\frac{1}{2}$-inch flues with a 2- or 3-inch expander. This is where the fun begins, for the 2-inch rollers won't fit the 3-inch pin and the 3-inch rollers won't fit the 2-inch pin; even if they did you would have a hard time keeping the rollers at home. All that is necessary, is to borrow the good housewife's new 10-cent shears, hunt up a few tin cans and cut out a goodly supply of bushings. With an over-abundant supply of patience to complete the list, it is possible to roll a dozen flues in the course of an afternoon.

Another case which I think will bear mentioning is that of a locomotive on a small Western road — a ten-wheeler of the Pittsburgh type, I think. While making some minor repairs on the left-hand cylinder, it was discovered that the wall between the cylinder and port was cracked, the crack taking in a semi-elliptically shaped piece of about 25 square inches. To run the engine in the back shop and put on a new cylinder and saddle meant throwing it out of commission for at least three weeks, to say nothing of the loss incurred by getting a new cylinder, etc. It was repaired in the unique but thoroughly satisfactory




FIGS. 64 and 65. — Some quick Repair Jobs.

manner shown in Fig. 65. The broken section was first carefully drilled, reamed and countersunk for three $\frac{3}{4}$-inch screws and was then replaced and the corresponding holes in the port wall carefully scribed, drilled and tapped. Three $\frac{3}{4}$-inch collars were made of $1\frac{1}{2}$-inch mild steel, these being cut off to a length of about $\frac{1}{16}$ inch greater than the corresponding width of steam port. Each collar was separately fitted into place, brought to a fair bearing and the broken piece fastened in place with screws well sent home. To prevent leakage at the crack a $\frac{1}{4}$-inch dovetail slot was cut at the junction of the two pieces and a piece of annealed copper wire peened in. The job was completed by truing up the cylinder with a boring bar, and to my knowledge is giving good service yet.

## REPAIRING CRACKED GAS ENGINE WATER JACKETS

HAVING had to repair several gas-engine water jackets that had been cracked by the freezing of the water in them, this is how it was done.

I first chipped a dovetailed groove, following the crack, about half the thickness of the jacket in depth by $\frac{1}{4}$ inch width at the top and $\frac{5}{16}$ inch at the bottom. I then ran the groove full of solder, peening it in carefully and smoothing it off and got a very good job.

I have watched for several months a number of engines that I have repaired in this way, and the indications are that the job is permanent and satisfactory in every way and much cheaper than a new cylinder. As an experiment I filled one groove with a cast-iron cement called "Smooth-On" and, while it has held so far, I think that in time it will crumble from the vibrations and begin to leak again, but it offers another way out of a difficulty if one does not happen to have the facilities for soldering at hand.

## A HURRY-UP AUTOMOBILE JOB

NOT long since a man came to the shop, dragging an automobile of Italian make. Some of the bolts holding the cylinders to crank base

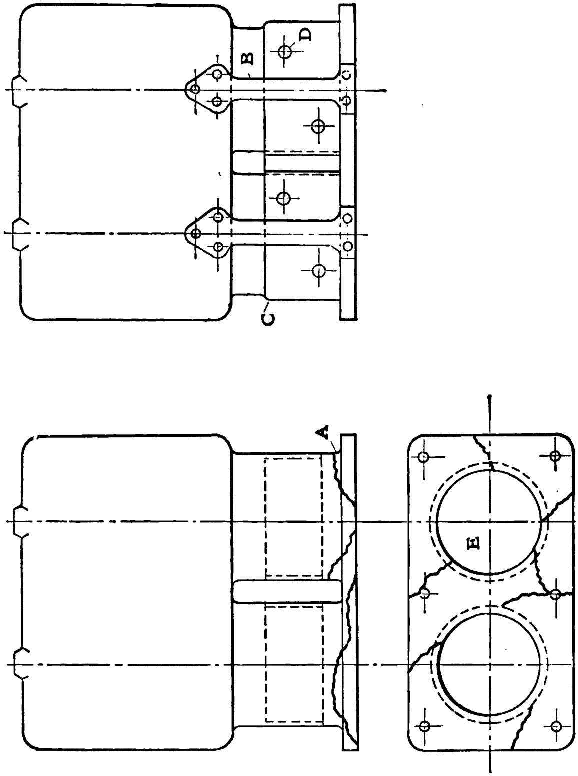



FIG. 66. — Repairing Automobile Cylinders.

came loose and broke the flange off, as shown at *A*, and left it in six pieces, as at *E*.

It was impossible to get other cylinders as the firm were making, a new type and the old patterns had been destroyed.

I shellacked the parts together, had the patternmaker make a templet of wood for drilling bolt holes, also a pattern for a new flange as shown at *C*.

I then put the cylinders in the boring mill, faced and turned them as in dotted lines, Fig. 66. I planed the face of the new casting, put it in the mill, bored it, allowing 0.004 forcing fit, forced it in place, tied it with eight screws *D*, and four straps, *B*.

## REPAIRING A BROKEN AXLE

THE accompanying sketch shows how an automobile axle was repaired so as to run home a distance of 12 miles without the aid of a hay motor.

The front axle broke square off next the shoulder for the cone. The two parts were taken to

a country blacksmith, where a half-inch hole was drilled and tapped in the center of each piece; a half-inch pin threaded on each end was then put in these holes and the two pieces screwed together and securely brazed.

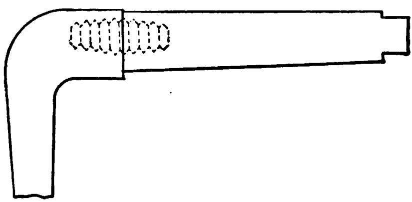


FIG. 67. — Repairing Automobile Axle.

## REPAIRING A STEAM HAMMER

THE sketch, Fig. 68, shows a repair on a steam hammer. This hammer had been in use for a number of years, when a crack was noticed at the back of the frame, extending from the back to about the center of the section. In the sketch, which shows a side elevation of the hammer, the crack is seen at $x$. The hammer was used for some heavy work after the crack was discovered, and gave no sign of distress; but, notwithstanding

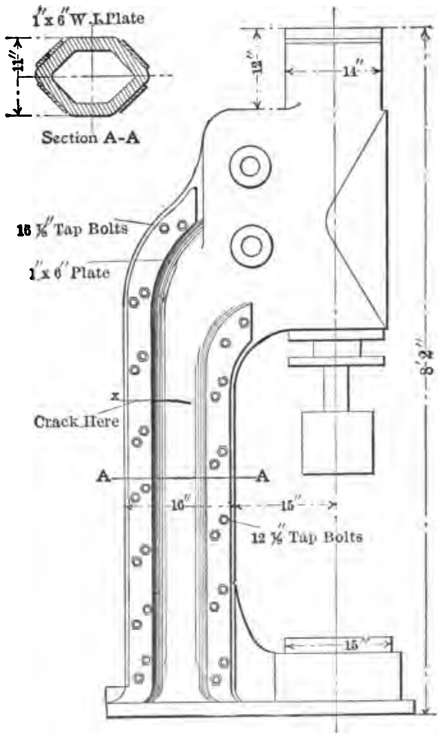



**Fig. 68. — Repairing a Steam Hammer.**

this, it was thought best to repair it, or the fracture might go through the whole section. I myself cannot explain the cause of this crack, for it seems to me that the orthodox way for that frame to crack would have been on the opposite side, where the metal was in tension when doing work. The repair was made in the following manner:

Four pieces of 1 x 6 inch plate were fitted to the hammer frame, as shown in the section. The large plates were bolted to the frame by sixteen $\frac{7}{8}$-inch tap bolts, while for each of the small plates twelve $\frac{7}{8}$-inch tap bolts were used. The sketch shows the hammer after undergoing repairs.

## STRAIGHTENING A LARGE SHAFT

THE accompanying illustration, Fig. 69, shows a rig made for straightening shafts. The shaft, in this instance, was 8 inches in diameter by 11 feet and 6 inches long, and was $\frac{9}{16}$ of an inch out of true at the part over the forge. I first raised the lathe up, as shown, then made two

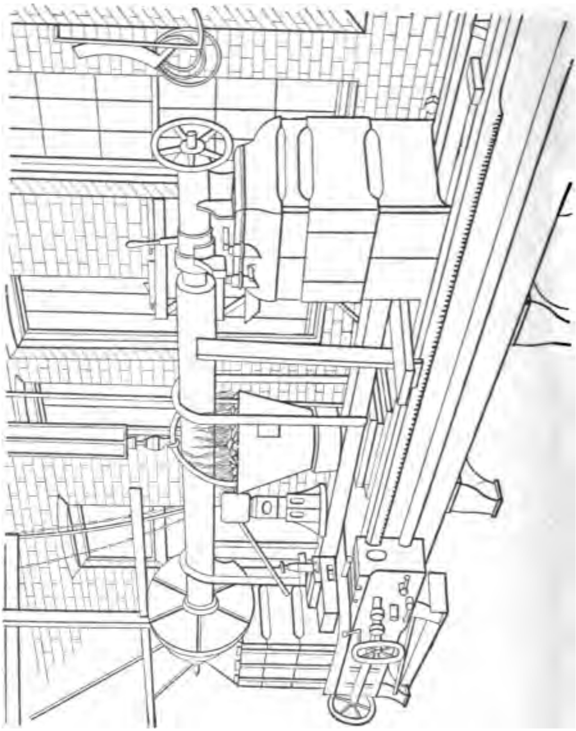


FIG. 69. — Straightening Large Shaft in Lathe.

U-bolts 2 inches in diameter; with cross-pieces and nuts. Then I cut two 90-lb. steel rails and placed them side by side in the U-bolts as illustrated, then made the portable forge and rigged up an air supply for it.

I started a fire in the forge, at the same time revolving the shaft slowly and gradually bringing it up to a red heat at the bend, at the same time easing up at the centers as the shaft expanded. After getting the shaft sufficiently hot I removed the forge and brought a 40-ton hydraulic jack, as shown, into place; I then put about 30 tons pressure on the shaft at this point, and upon releasing the jack the first time I found that I was $\frac{1}{4}$ inch nearer true than at the start. By putting pressure on with the jack several times I was within $\frac{3}{64}$ inch of being true. I rotated the shaft until I found the lowest point, then put on 40-ton pressure and let it stand over night to cool off. On releasing the jack in the morning we found the shaft within 0.010 inch true.

By this means of straightening it takes all strain off of the lathe centers, and it is possible

to bring the shaft sufficiently true for all practical purposes.

## RECUTTING STRIPPED NUT AT SEA

THIS is the way I cut a square-thread nut while engineer in a British tramp steamer years ago. In those days Monaco and the adjacent Monte Carlo, of evil fame, were lighted by gas. We were lying at the coal wharf, discharging 2000 tons of gas coal. The donkey boiler situated on deck was supplying steam for the winches, so the main boiler (we had but one) was at our disposal for much-needed repairs. While packing the main stop valve I discovered accidentally that the nut *B*, Fig. 70, was nearly worn out. In the illustrations *A* shows the cap of the main stop valve with the yoke cast in one piece. The nut *V* for the screw *C* is let in from underneath and has a flange to take the thrust. It is held in place by the set-screw *Q*, shown in the lower illustration. I took the cap off the valve and knocked the nut *B* out. In the storeroom I found an old winch gland, *E*, of brass, which was

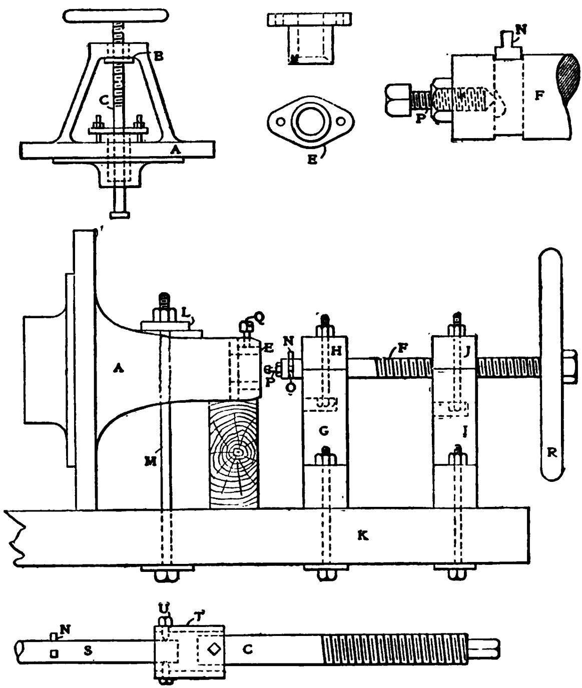



FIG. 70. — How the Nut was Cut.

a little smaller than *B*. I wrapped a strip of tin around the body and drove it into the yoke. On measuring the screw *C* I found it to be about $1\frac{3}{4}$ inch outside diameter, four square threads to

the inch. The screw *C* was in new condition, having been in use only about three months. A further search in the storeroom revealed an old valve spindle, *F*, 1¼-inch diameter, the same pitch as *C*, with the thread in good condition. I decided to use this, as it would save me considerable trouble in the cutting of the new nut over what I would have if I used the spindle *C*.

I got a piece of plank, *K*, 3 inches thick by 12 inches wide and about 4 feet long. This was trued up on one side and one edge so as to facilitate setting the different members of my threading machine. The cap *A* was bolted in place as shown, care being taken to have it square and parallel with the plank *K*. An "old man" was then bolted to the plank and the nut *E* bored a little larger than the bottom diameter of the thread *C*. The wooden bearing *G* was then put in place and its cap *H* fitted. A bar with a scriber on its end was passed clear through the cap *A* and nut *E*. With this a circle was scribed on the face of *G*. After transferring the circle to the other side, the bearing was worked out

with a gouge. The bearing *I* was then bolted in place, scribed and worked out in the same way, but the hole in *I* was only the size of the spindle *F* at the bottom of the thread, while that in *G* was the size of the plain part of the spindle. The thread on the spindle *F* was then roughed with a chisel so as to cut a thread in the bearing *I* and cap *J*. Both the caps *H* and *J* were put on loosely and gradually tightened down, while the screw *F* was rotated by the hand wheel *R*. After the thread was cut in *I* and *J*, the spindle *F* was taken out, the burs filed smooth and the square-threading tool fitted in the end. The end of *F* is shown enlarged at the upper right-hand corner. The square tool *N* was held in the hole by a set-screw *O* on the side. The pointed screw *P* and the inclined face on the tool *N* regulated the depth of cut. For the first four or five cuts the tool was driven back each time at the extreme end of the cut, so as to clear the thread on the backward stroke, but after the thread was about $\frac{1}{32}$ inch deep this was found unnecessary. The thread was a good one, but it seems to me at this late date that I have taken considerably

longer to describe the job than I originally took to do it.

I suppose while I am about it I better tell you how I would have cut that square thread if I had been unable to find that other spindle *F* which suited my purpose so admirably. I would have taken the spindle *C* of the valve and a piece of round steel or iron of suitable size, *S*, say 1¼ inches or less in diameter by 18 inches long. I would have fitted up two plain bearings like *G* and spaced them a suitable distance apart. I might have put one on one side of the nut *E* and one on the other, as close as convenient for handling the threaded tool. The next job would have been to make the threaded wooden journal, like *I*, to fit the spindle *C*. Then I would have taken a piece of pipe or old boiler tube and made a universal joint *T* by drilling holes clear through at right angles to each other. After threading these and fitting four pointed set-screws *U*, I would have spotted the spindle end to suit two of the screws and the round rod to suit the other two. After fitting an adjusting tool, like *N*, in the round rod and coupling the

rod and spindle together with the universal joint, the rig would be ready to put in the wooden bearings to cut the thread.

## BENDING WOODEN STRIPS

THE accompanying sketches are to show how I bent the wooden shoes for a friction clutch, without any special tools. The clutch in question was a 40-inch clutch coupling, the shoes being, as I recollect them, about $\frac{7}{8}$ inch thick, 4 inches wide and 10 inches long.

We had plenty of 4-inch maple plank on hand, and sawed four $\frac{7}{8}$-inch strips out of it, the strips being about 8 feet long. This was enough to make all the shoes we wanted and have some left over. After sawing, the strips were smoothed with a plane, to lessen the work of fitting. Some old strips of sheet brass of about No. 30 B. W. G. and of proper width, which we happened to have on hand, were cut into lengths, the ends annealed, and then turned over the ends of the wooden strips and secured by screws, as shown in Fig. 71. The object of the brass strips was to prevent

very much stretching of the fibers on the outside of the stick.

One of the steam boilers at the plant being out of commission, I determined to use it as a steaming box. It was a horizontal fire-tube boiler of the ordinary type, with a manhole at the front end to serve as a door. I put a couple of short sticks crossways of the boiler and laid the maple strips on them, shut the manhole and filled the boiler with steam. While the wood

FIGS. 71 and 72. — The Strips of Wood and the Clamps.

was steaming, we rolled an old 40-inch pulley out of the cellar, laid it on the ground outside the boiler-room and drove a couple of stakes between the arms to keep it from turning.

I next called on the blacksmith and got him to make a few clamps of $\frac{3}{4}$-inch round iron, like the one sketched in Fig. 72.

After three or four hours we judged that the wood was sufficiently soft, and, shutting off the

steam, we knocked out the manhole plate and fished a strip of wood out with a pair of long-handled tongs.

The strip was placed in position, a clamp driven on, a big wrench put on the other end, and the strip was slowly bent around the pulley. A second man followed the wood up with a hammer, rapping it into place and driving on clamps where necessary. Fig. 73 shows the operation of bending. When one strip was secured, the pulley was turned over and the operation repeated on the other side. A second 40-inch pulley was used for a former for the other two strips.

The wood was dried by putting the strips (pulleys and all) on top of a boiler. After a few days' drying, the clamps were knocked off, the brass bands removed and the best portions of the bent wood sawed to approximate length and put away for use as shoes for the clutch.

The usual way of bending hoops for a cider press was by hammering. "The Professor" hit upon the idea of using a pulley and belt to bend the hoops, and he found that, starting as in

Fig. 74, and running once around, made the hoops ready to be riveted. The old note-book from which this is taken says that a pulley

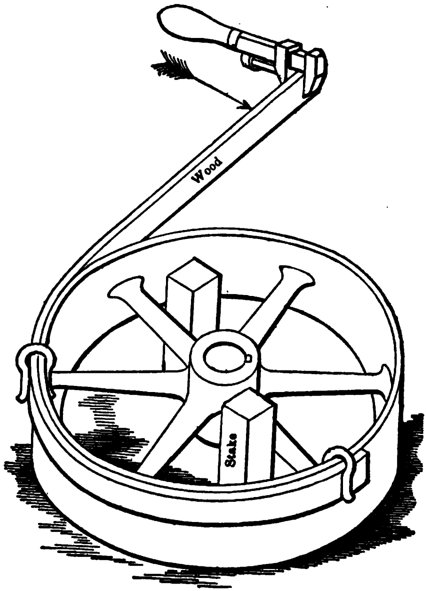



FIG. 73. — Bend Strips of Wood.

should be selected about one inch smaller than the required diameter of the hoop, and that the belt should be pulled by hand. It would seem

that the straight part of the belt between $A$ and $B$ is the main factor in bending, because it holds against the bending stress exerted by the pulley and belt. This is clearly an improvement in a process without new tools, as the stock was bent

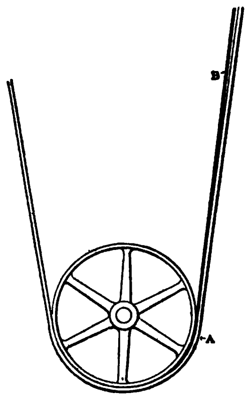



FIG. 74. — Bending Hoops.

around the cone pulley of a lathe that happened to be out of use.

## RECUTTING A HALF NUT

FIG. 75 shows how I saw a long half nut of relatively small diameter re-chased. An ordi-

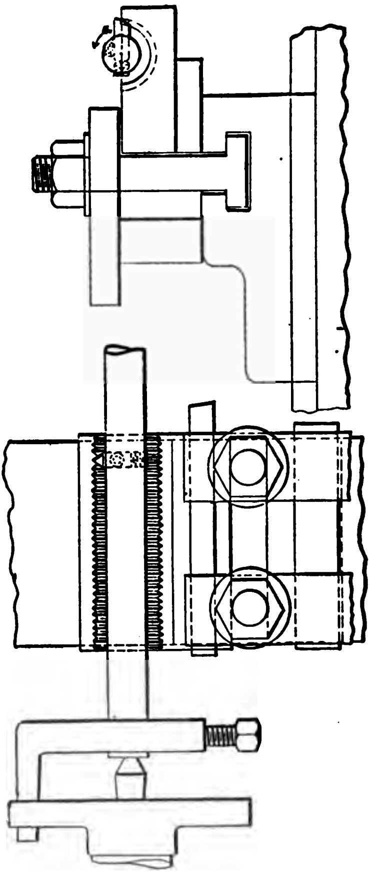


FIG. 75. — Recutting a Half-Nut.

nary boring bar was run between the centers in a lathe, and the half nut was clamped to the tool-block of a rise-and-fall carriage. The elevating screw and cross-slide screw allowed of fine adjustment in setting up. The tool was held in bar just tight enough so that it could be fed out by the headless screw at the back of it. The job when completed was all that could be desired. The lathe was stopped after each cut, the carriage was run back and tool fed out for the next cut.

I think this was much more quickly and easily set up than clamping to an angle plate on the face-plate, and the boring bar being supported at both ends allowed of a heavier cut than had been possible with an ordinary thread boring tool of such length and thickness. There was no more spring at one end of the nut than at the other.

## REPAIRING A TOOL-POST SLIDE

As it is so seldom that a forced repair job is equal to the work in its original form, a case in

which the repair is better than new is certainly an oddity, and the way in which we fixed the tool-post slide, being a case of this kind, is of note.

The trouble to be overcome was the crushing of the ribs in the tool-post slot, due to a heavy cut with the boring tool.

In repairing the break, the sides of slot were

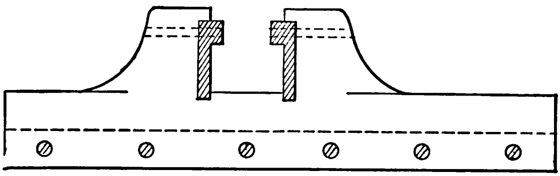


FIG. 76. — Lining a Tool-post Slot.

planed out and steel pieces were fitted closely, as shown in Fig. 76, in shallow grooves at the lower edge and under lips at the top, and were secured by three rivets in each, thus providing solid metal supports and bearing for both turning and boring strains, and as the wear is taken by the steel inserted pieces, it is really better than when built.

## CLAMPING A PULLEY OVER A FLANGE COUPLING

A COUPLING or a hanger often comes on a shafting line at a point where a pulley is required. A hanger can generally be shifted, but to shift a coupling by changing or moving the shafting lengths into different positions is usually too expensive for consideration.

Here is how a 10-inch face, 24-inch diameter wood split pulley was put on a flange coupling of a main shaft to drive, by means of an 8-inch double belt, an extra large drop hammer.

The pulley was first re-bored to 6 inches scant, so as to make a good clamping fit on the hubs of the coupling. To allow the pulley to go on at the 11-inch diameter, 4-inch wide flanged portion of the coupling, it was partly bored and partly chiseled out, as shown by the dotted lines, Fig. 77. Two plates $\frac{3}{16}$ inch thick, of wrought iron, were used to strengthen the pulley where cut away and to reinforce its clamping grip.

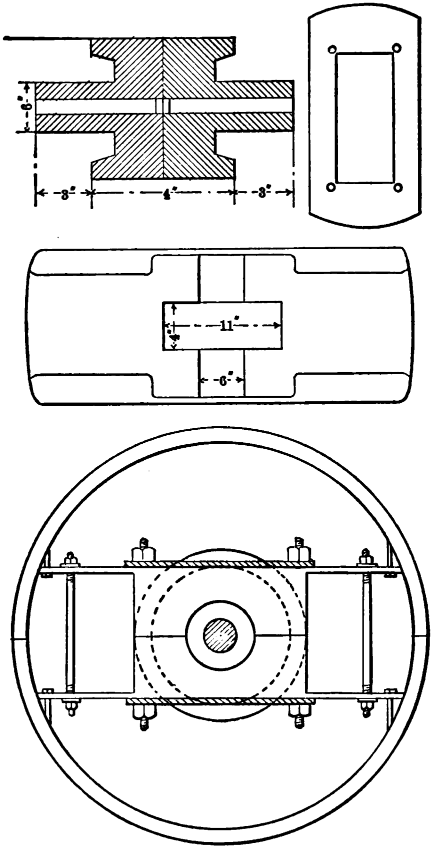



FIG. 77. — Clamping a Pulley over a Flange Coupling.

## AN AUTOMATIC FEED FOR RATCHET DRILL

The genius displayed in the improvised automatic feed for a ratchet drill and shown in

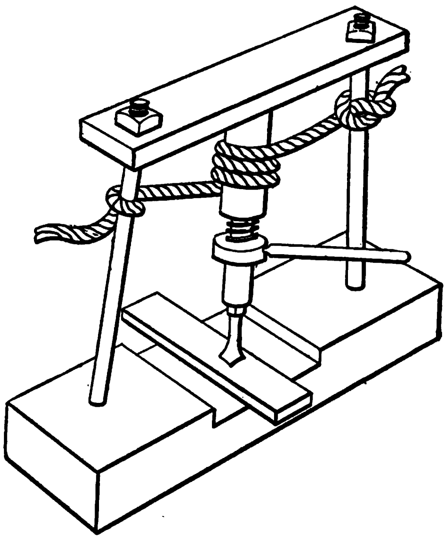


Fig. 78. — An Automatic Feed.

Fig. 78 is certainly unique in many ways. By taking the required number of turns about the sleeve of the ratchet drill (which required

number of turns would be indicated by the behavior of the drill itself) he was able, by tightening or loosening the rope a little, to get any desired rate of feed, and of course it was automatic. The thing seemed to be working well, and is one of those things which are sometimes evolved by men who have little idea of the ingenuity that may have been previously expended upon similar problems. This can be used with any ratchet.

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